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Editorial: Proceedings of the 2016 and 2017 workshops on 'Integrated Microscopy Approaches in Archaeobotany'

Rowena Y. Banerjea[1], Catherine Barnett[1], Lionello Morandi[1, 2], Marta Portillo[1]

[1] University of Reading, Department of Archaeology, Reading, UK

[2] Eberhard Karl University of Tübingen, Institute of Scientific Archaeology, Tübingen, Germany

ORCID ID

Rowena Y. Banerjea 0000-0002-1786-357X

Catherine Barnett 0000-0002-6156-1640

Lionello Morandi 0000-0001-8840-6096

Marta Portillo 0000-0002-2703-031X

The collection of papers in this special issue arises from research presented at the 2016 and 2017 workshops in 'Integrated Microscopy Approaches in Archaeobotany' held at the University of Reading, UK. The aim of the workshops was to bring together students and specialists in geoarchaeology, biogeochemistry, plant macroremains, anthracology, palynology, non-pollen palynomorphs and phytoliths who are working in universities, major heritage organisations, curatorial bodies, and commercial archaeology companies in order to share research and skills. Since then, the IMAA workshops have been successfully celebrated in Reading every year, testifying to the growing interest for archaeobotanical microscopy approaches in conjunction with other proxies, and particularly from the field of geosciences.

Archaeobotany is the study of archaeological plant remains, which include plant macroremains, such as seeds and charcoal, and a range of associated microfossils, such as phytoliths, pollen, spores and starch grains. These papers showcase a range of microscopy approaches that can be applied to examine and interpret botanical and organic assemblages in the archaeological record, and to address a range of topical research themes and current debates in archaeology, such as environmental management, human responses to environmental change and sustainable life-ways spanning a broad geographical and chronological time periods. Soil micromorphology is a technique that enables the formation and post-depositional processes of archaeological deposits to be understood by reconstructing sediment histories. It allows archaeobotanical remains to be examined within their depositional context to provide a micro-contextual interpretation of the evidence, and to understand different types of archaeobotanical remains in a range of preservation conditions (e.g. Matthews 2010; Vrydaghs *et al.* 2016; Ismail-Meyer 2017; Ismail-Meyer *et al.* 2018). As with many other proxies, formation processes and taphonomy are key issues in the study of any type of plant remains (e.g. Van der Veen 2007; Matthews 2010), and this is reflected in several contributions of this volume.

Banerjea *et al*. and Borderie *et al*. both address an absence of multi-proxy environmental archaeological studies on European castle sites from the medieval period, and particularly to understand the early development of these sites. In both these papers, the integrated results have allowed the potential of these proxies to be powerfully exploited to show new archaeobotanical perspectives on the function and development of these castle complexes and their relationships with the castle's hinterland.

Banerjea *et al*. use soil micromorphology, plant macroremains, phytoliths and palynology results from two castles in the Baltic (Elbląg, Poland, and Karksi, Estonia) to show changes in animal husbandry through time, whereabouts within the castles the animals were stabled, and livestock alimentation. The study represents an important investigation of deposits from medieval castles, particularly from the period of active Crusading that are rarely revealed through excavation and in the past have rarely been subjected to an integrated environmental investigation.

Borderie *et al*. use soil micromorphology, plant macroremains and phytoliths, including their morphometric analysis, to understand floor preparation materials, maintenance practices, and domestic, metallurgical and animal husbandry activities to provide new evidence of the richness and the complexity of the town, and of the activities which could take place within early *castra.* Morphometric analysis of phytoliths in micromorphological thin-sections showed cultivated cereals which were processed *in situ*, such as *Triticum durum*, *Secale cereale* and *Hordeum vulgare*.

The paper by Vrydaghs and Devos propose a system for the simultaneous observation and description of phytoliths in thin sections of soils and archaeological sediments. It presents three aspects of phytoliths in thin section, namely VPC index: (V) visibility, expressing to what extent these are masked and/or surrounded by fine material; (P) preservation, as indicator for the physic-chemical alterations that affected them; (C) colour, describing the extent to which the phytoliths are coated by other particles and indicator for the charring of the organic material surrounding them. This paper presents an important contribution towards the standardised description and recording of phytoliths in thin section to facilitate comparison and interpretations of microfossil datasets from different sites and research areas.

A good knowledge of livestock management and herding practices is crucial when investigating the subsistence of farming societies. These aspects do not always have a good visibility within the archaeological record, so that archaeobotanical evidence should be employed to shed light on them, along with other analytical techniques including contextual micromorphology as above outlined, and direct microscopic dung indicators such as calcitic spherulites, coprophilous fungal spores, isotopic and biomolecular signatures, along with zooarchaeological remains from different origin. Of particular interest for unveiling pastoral and agro-pastoral activities in archaeology is understanding the nature and taphonomy of animal dung remains, which is in this issue explored in archaeological and modern ethnographical contexts through the use of direct and indirect proxies of various origin, including in vegetal micro-remains such as opal phytoliths and calcium oxalates, as well as faecal indicators such as fungal spores and calcitic spherulites that form in the digestive system of a variety of animals (e.g. Shahack-Gross 2011; Friesem 2016, and references therein).

Two papers deal with both ethnoarchaeological plant and dung microfossil evidence for livestock management (Dalton and Ryan; Morandi).

The study of Dalton and Ryan on a New Kingdom pharaonic settlement in Sudan combines dung spherulite and phytolith analyses of desiccated and charred ovicaprid dung pellets as well as faecal material in thin-sections, with further support provided by micromorphological evidence and chemical signatures. Their experimentally produced datasets from modern reference materials suggest differences in dietary calcium intake and feed Ca availability implicated in dung spherulite crystallization within ovicaprid digestive tracts, thus providing new insights into spherulite formation aspects poorly-defined to date.

Analysing a sequence from a recent pastoral cave context in northwestern Italy, the paper by Morandi also follows an integrated approach combining direct faecal microfossil indicators from calcitic spherulites and coprophilous fungal spores, which are more widely utilised in wetland palaeoecology to assess past herbivore presence (Baker *et al.* 2013; Johnson *et al.* 2015). This study highlights the contribution of ethnoarcheological approaches to understand microfossil taphonomy and their distributions better within penning deposits.

The paper by García-Suárez, Portillo and Matthews presents micro-contextual studies in open site areas through simultaneous examination in thin section micromorphology and integrated phytolith and dung spherulite analyses for the identification of early animal management strategies in the Konya Plain, a key region in the origins and spread of Neolithic innovations in Central Anatolia, Turkey (e.g. Hodder 2006; Baird *et al*. 2018). Dung assemblages are identified at high-resolution studies from extensive midden deposits at the early agricultural site of Boncuklu, as well as at the later occupations of Çatalhöyük and the Late Neolithic settlement of the Pınarbaşı rockshelter, thus proving direct evidence for animal management, diet and ecological diversity, as well as for site formation and organization of the space of early settled life. In sum, all three papers within this section show the potential of archaeobotanical microfossils and other micro-remains for reconstructing livestock management, animal diet and potential indicators of seasonality.

No proxy record has the ability to enable reconstruction of past landscapes in isolation. However, substantial on-site archaeobotanical macrofossil assemblages including charcoal do offer the opportunity to examine aspects of the local landscape and presence/absence of exploited habitats across the wider source area (Théry-Parisot *et al.* 2010; Asouti and Austen 2005, Chabal 1997). The presence of charred wood on an archaeological site relies on it having been gathered and transformed through use or discard, and so its examination can also provide insights into a range of human activities and targeted resource exploitation (Théry-Parisot *et al.* 2010; Smart and Hoffman 1988). Despite these opportunities for knowledge gain, analysis of charcoal, and to a degree other on-site macroscopic proxies, such as mollusca and coleoptera, are often overlooked, underestimated or felt to be a poor relation of plant macrofossil analysis as a tool in archaeological studies.

Reflection is made in the paper presented in this volume by Barnett on whether systematic, large-scale, analysis of wood charcoal is of significant value in understanding landscape, resource use and lifestyles at and around Iron Age Silchester and the wider implications of that reflection are considered. Barnett's paper shows that anthracology has high potential to inform not only on the presence of tree and shrub taxa in the past but also on the structure and location of former woodlands, heathlands and wetland fringes.

Lastly, Portillo and colleagues present an extensive and up-to-date review of the literature dedicated to morphometric investigations in archaeobotany. Over the last few decades, morphometrics have particularly contributed to the study of the domestication and spread of many crops around the world, such as cereals and legumes, underground storage organs (USO), and fruits, including olives, grapes, dates, and bananas (e.g. Terral *et al*. 2004, 2010; Willcox 2004; Fuller 2007, 2017; Ball *et al*. 2016, and references therein). This paper presents an overview on current methodologies, recent applications, and advances in the use of morphometrics for various types of plant remains (mainly seeds, pollen, phytoliths, and starch grains), its applications for improving taxonomic resolution, and discusses its contributions to addressing major research questions, challenges and possible future directions in archaeobotanical research.

Collectively, the papers explore ways to address the challenges of integrating and presenting datasets that were recovered from a) multiple sites and b) through different types of excavation, often within the same project. Arising from these issues stems a necessity to understand the sampling and data interrogation requirements of fellow specialists. Overall, the articles included in this volume illustrate a range of perspectives by which microscopy approaches in archaeobotany contribute to address main research questions and current debates in archaeology, making these studies a valuable research tool especially when integrated with other proxies.

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